

WHAT IS CLAIMED IS:

1. A method of dry-etching a multi-layer film material including a thin metal film, wherein a combination of at least one of gases including a gas containing a carbonyl group and a gas containing a halogen element, and an electron donating gas is used as an etching gas.

2. A method of dry-etching a multi-layer film material including a thin metal film, wherein a combination of at least one of gases including a gas containing a halogen element, an inert gas, an oxygen gas, and an ozone gas, a gas containing a carbonyl group, and an electron donating gas is used as an etching gas.

3. The method of dry-etching the multi-layer film material according to claim 1, wherein the electron donating gas is a gas containing at least one selected from the group consisting of SF₆, PH₃, PF₃, PCl₃, PBr₃, PI₃, CF₄, AsH₃, SbH₃, BiH₃, SO₃, SO₂, H₂S, SeH₂, TeH₂, Cl₃F, H₂O, H₂O₂, phenols, alcohols, polyhydric alcohols, carboxylic acids, ethers, aldehydes, alkyne containing two to five carbon atoms, alkene containing two to five carbon atoms, and alkane containing one to five carbon atoms.

4. The method of dry-etching the multi-layer film material according to claim 1, wherein the multi-layer film material including the thin metal film is a multi-layer film material having a three layer structure of a magnetic layer, a tunnel barrier layer, and another magnetic layer, comprising the step of:

stopping etching at the tunnel barrier layer in dry-etching, wherein at least one of increasing a ratio of flow rate of the gas containing the carbonyl group and decreasing a ratio of flow rate of the gas containing the halogen element is achieved in the etching gas prior to exposing the tunnel barrier layer.

5. The method of dry-etching the multi-layer film material

according to claim 1, wherein the multi-layer film material including the thin metal film is a multi-layer film material having a three layer structure of a magnetic layer, a tunnel barrier layer, and another magnetic layer,
5 comprising the step of:

stopping etching at the tunnel barrier layer in dry-etching, wherein in a latter etching process after the step of stopping etching, a pattern of the magnetic layer formed in a former etching process prior to the step of stopping etching is covered to be dry-etched.

6. The method of dry-etching the multi-layer film material according to claim 1, wherein the method further comprises the step of removing a polymer film at a sidewall of a pattern formed by dry-etching by using as a rinsing solution a liquid containing at least one selected from the
5 group consisting of sulfuric acid, hydrochloric acid, ammonia, cyanide, and alkylamin, or pure water.

7. The method of dry-etching the multi-layer film material according to claim 6, wherein in the step of removing the polymer film at the sidewall of the pattern by using the rinsing solution, a change of the rinsing solution or the rinsing solution having been already used in color,
5 electric conductivity, or specific gravity is used to detect an endpoint of a reaction.